



Australian  
National  
University



The first vehicle made  
with green steel! 2021

*ZERO-EMISSIONS INDUSTRIES AND THE ROLE OF HYDROGEN*

# Green iron and steel

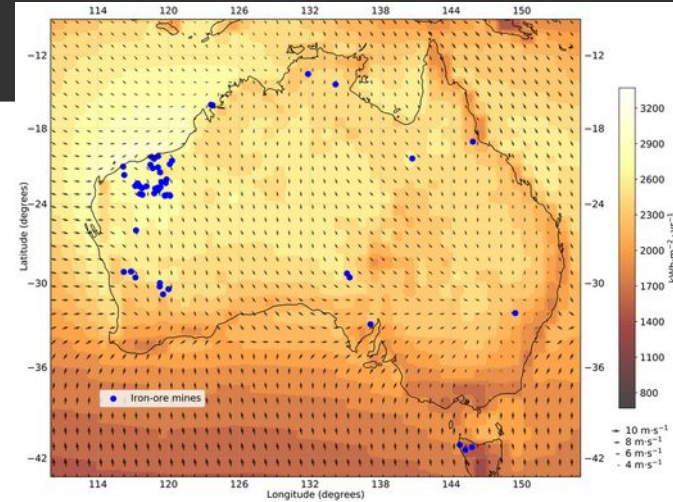
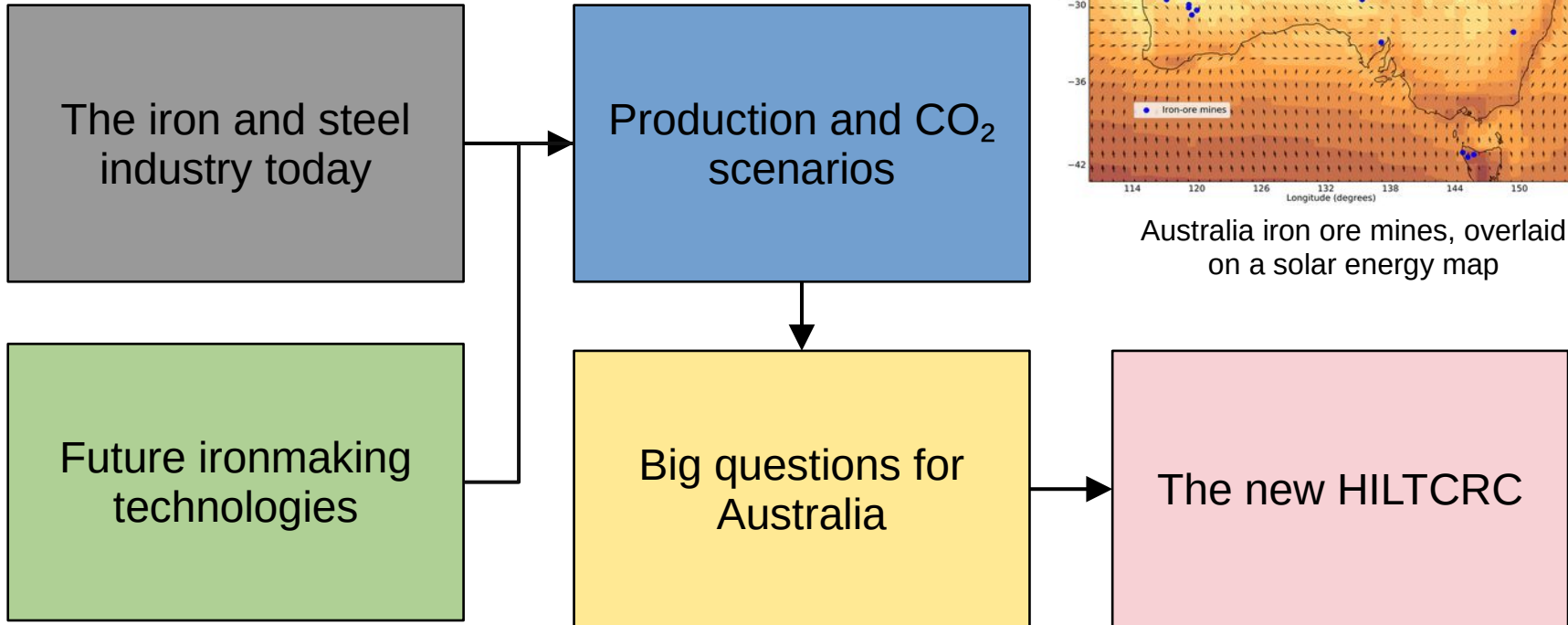
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Convenor,

*ANU Energy Update, Canberra, 1 Dec 2021*



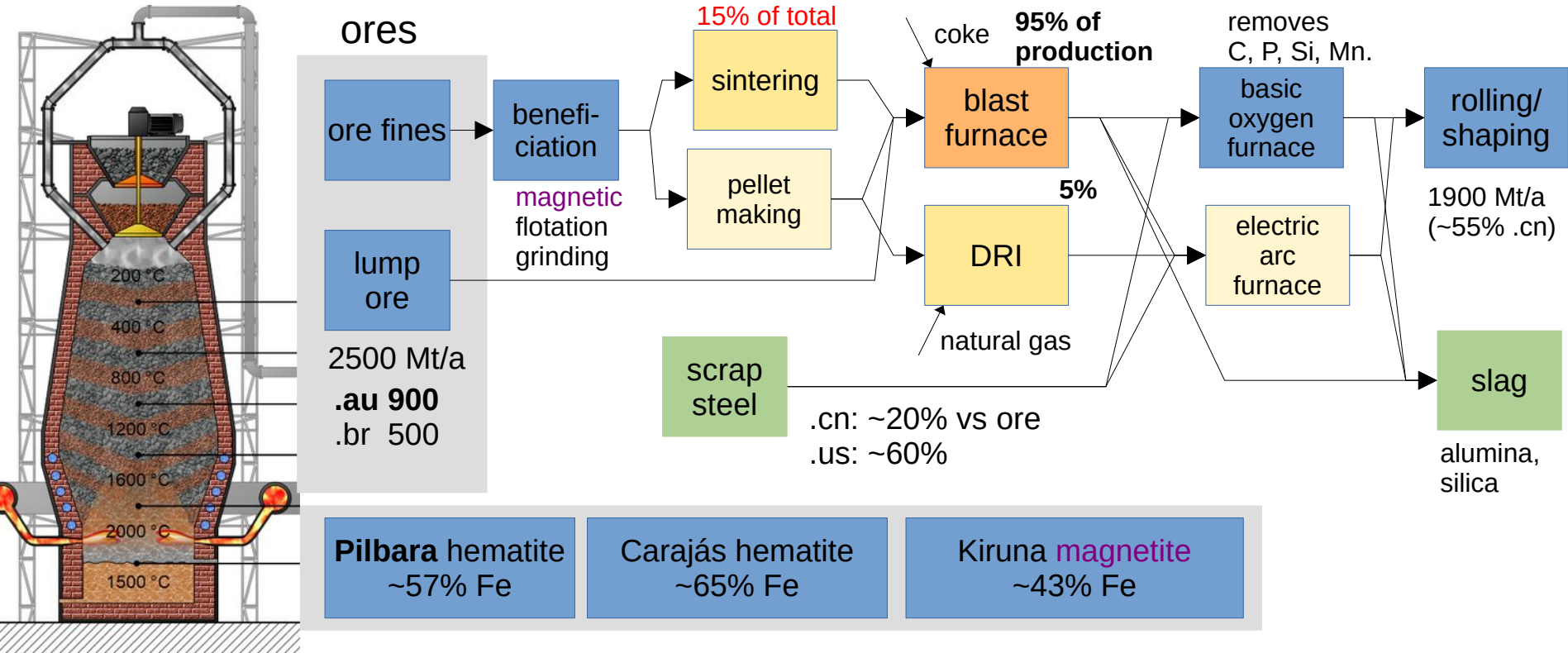
# Outline



Australia iron ore mines, overlaid on a solar energy map

# Iron and steel today

BF/BOF: 1.6-2.2 tCO<sub>2</sub>/t  
 Industry total: 7% of global CO<sub>2</sub>





# Future ironmaking



**HYBRIT** fossil-fuel steel produced with biofired pellets and H<sub>2</sub> furnace. In pilot phase.  
<https://is.gd/8QqyzF>



**thyssenkrupp** H<sub>2</sub> injection into BF ( $\leq 20\%$  CO<sub>2</sub> reduction)  
<https://is.gd/xHpUmx>



**Primetals** 'HYFOR' fluidised bed H<sub>2</sub> DRI (~100% CO<sub>2</sub> reduction)  
<https://is.gd/0NOrZI>

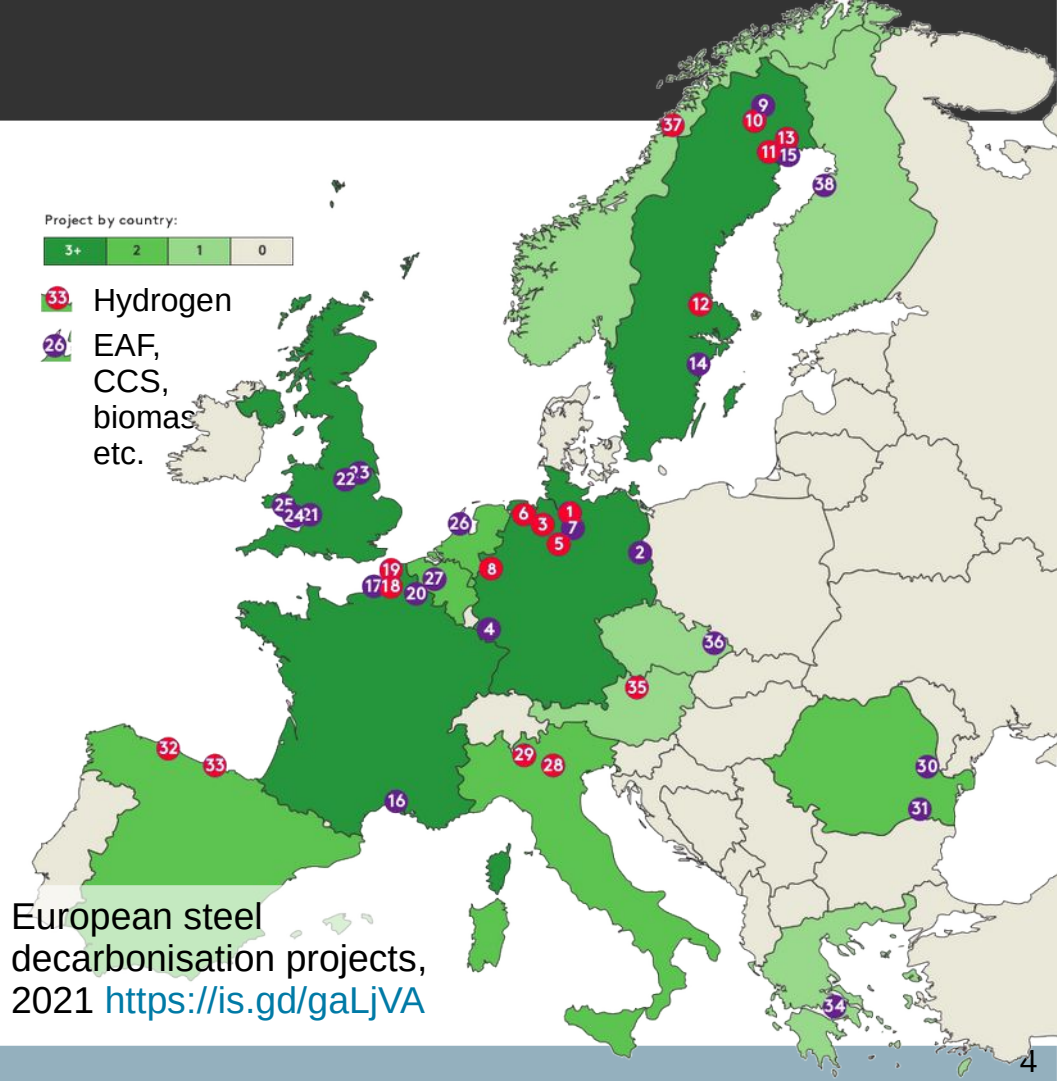


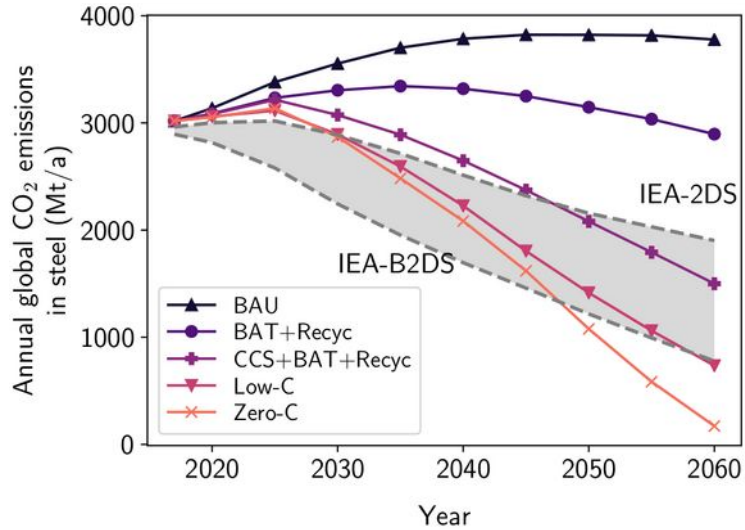
**Boston Metal** Direct pyroelectrolytic ironmaking (early days!)  
<https://is.gd/FKrgVS>

Project by country:

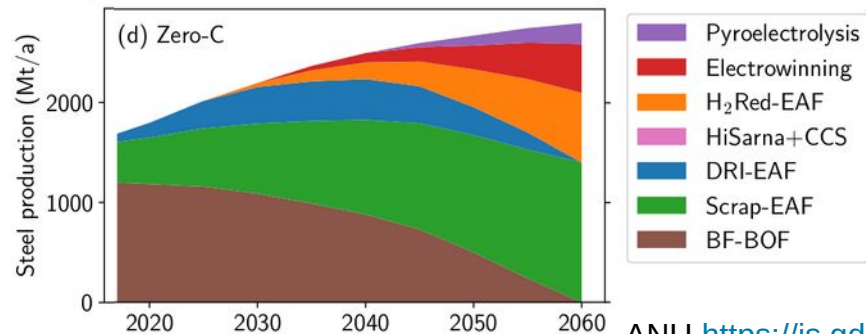
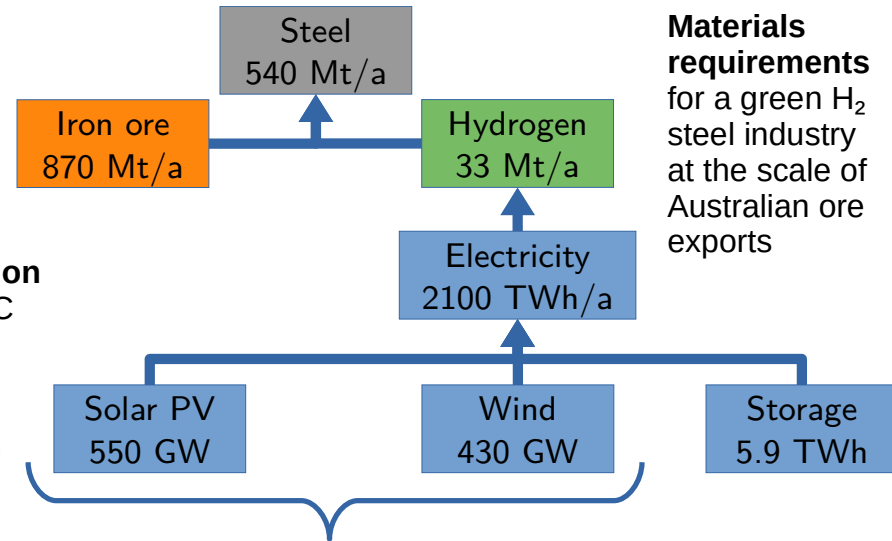


- Hydrogen
- EAF, CCS, biomass etc.





Emissions for different steel industry transition scenarios vs 2°C and 1.75°C 'budgets' (no DACCS/BECCS)



70%

25%

Glass 26 Mt	Steel 94 Mt	Aluminium 4.4 Mt
Copper 4.7 Mt	Silicon 2.2 Mt	Neodymium 21 kt
Concrete 190 Mt	Cast iron 8.6 Mt	Zinc 2.3 Mt

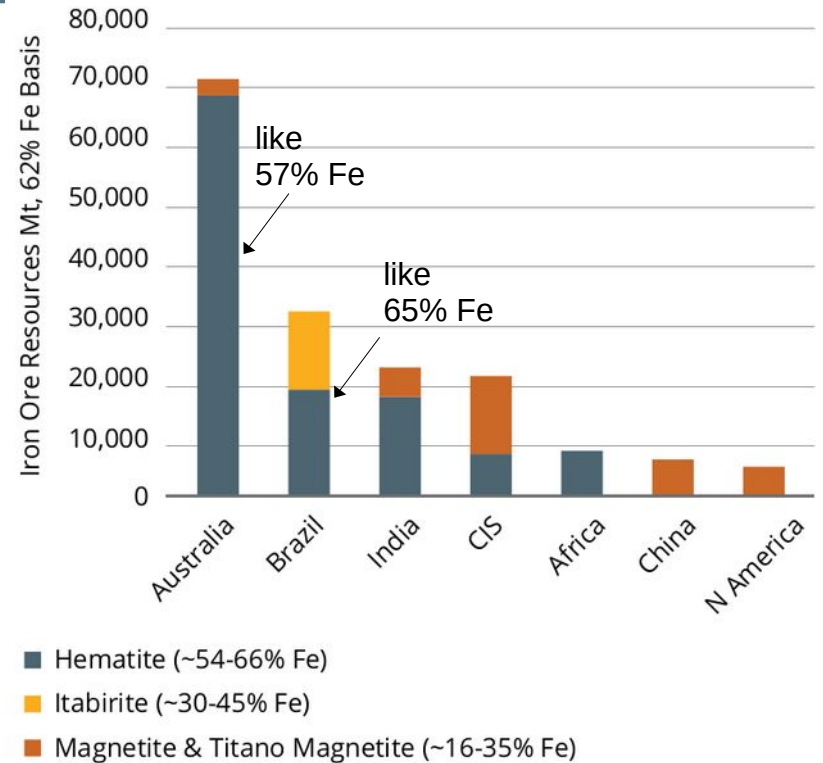
CRITICAL MINERALS

80% of one year's global production

25%

# Big questions for Australia

- Australia depends heavily on metallurgical coal exports and iron ore but in **neither markets** is our long-term position secure.
- As we transition to H<sub>2</sub> ironmaking, can Pilbara ores continue to have their dominant role?
  - How do we need to adapt H<sub>2</sub> ironmaking (or other) pathways to best handle our ores?
- Is a large-scale Australia steel industry feasible? Or pellet, or pig iron, or HBI?
  - Are our abundant renewable energy resources a big competitive advantage?
  - Reliable H<sub>2</sub> supply: what about energy storage?
- What industrial policy or market conditions (CBAMs?) would help move this forward?
- What will other countries do?



Minerals Council <https://is.gd/xaYNFA>

# The new HILTCRC

## Heavy Industry Low-carbon Transition Cooperative Research Centre

Process  
technologies  
eg iron, alumina,  
cement

Cross-cutting  
technologies  
eg H<sub>2</sub>, heat, CCU

Policy, economics,  
social issues  
roadmaps,  
life-cycle analysis

\$39M of Commonwealth funding over 10 years.  
Total program size \$175M including partner cash and in-kind.

- Detailed initial project plans are being finalised currently.
- ANU plans to actively contribute in the topic of steel industry decarbonisation, H<sub>2</sub> ironmaking, green process heat integration, H<sub>2</sub> supply infrastructure, scope 3 accounting, economics and industrial policy, and novel ironmaking processes.
- In parallel: many net-zero commitments from companies in this sector. Very actively engaged, with many parallel activities also outside the CRC.

## Core partners (>\$250k/a)



Other partners and more details:

<https://www.hiltcrc.com.au/>



**I would like to  
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Geoff Brooks  
Rod Dry

Lunar flux mapping at ANU SG4 big dish Photo: Martin Kaufer